Vol. XII. NOVEMBER, 1931 No. 12.

The American Midland Naturalist

Devoted to Natural History, Primarily that of the Prairie States

Published by the University of Notre Dame, Notre Dame, Indiana

PRICE, $1.50 A YEAR SINGLE NUMBERS, 30 CENTS FOREIGN, 6s, 6d.

Entered as second-class matter at Notre Dame, Ind. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3. 1917, authorized on July 3, 1918.

THE UNIVERSITY PRESS, NOTRE DAME, INDIANA

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The American Midland Naturalist

PUBLISHED BI-MONTHLY BY THE UNIVERSITY OF NOTRE DAME.
NOTRE DAME, INDIANA.

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THE OSTRACODE GENUS GLYPTOPLEURA

H. N. CORYELL AND GLADYS BRACKMIER

ABSTRACT

This paper brings together the figures and descriptions of the species of *Glyptopleura* Girty, six of which, have been described as members of this genus, seven have been transfered from the genus *Kirkbya* to the genus *Glyptopleura*, two are new species, described and figured here for the first time under this classification, one has been renamed by its former author and inserted here to make the list complete. The revised list places the following species in *Glyptopleura*.

Glyptopleura inopinata Girty
Glyptopleura angulata Girty
Glyptopleura costata (McCoy)
Glyptopleura plicata (Jones & Kirkby)
Glyptopleura salemensis Coryell & Brackmier n. sp.
Glyptopleura guardia Coryell & Brackmier n. sp.
Glyptopleura coryelli Harlton, new name
Glyptopleura spinosa (Jones & Kirkby)
Glyptopleura spiralis (Jones & Kirkby)
Glyptopleura mooreana (Jones & Kirkby)
Glyptopleura texana Harlton
Glyptopleura menardensis Harlton
Glyptopleura scotica (Jones & Kirkby)
Glyptopleura venosa (Ulrich)
Glyptopleura (?) *rhomboidalis* Girty
Glyptopleura emarginata Delo

REVIEW OF THE EARLIER WORK

A new family GLYPLOPLEURIDAE[1] and a new genus *Glyptopleura*[2] were made by Girty in 1910 to receive the two new species *G. inopinata* and *G. angulata*. *Glyptopleura* resembles *Kirkbya* from which it was distinguished by the presence of the inosculating longitudinal costae, and the left-over-right valvular overlap.

In 1915 Girty[3] added *G. rhomboidalis* to the genus. Because of its conspicuously reticulate ornamentation and distinct marginal ridge it should only doubtfully be referred to *Glyptopleura*.

E. O. Ulrich[4] described *Kirkbya venosa* in 1891. It has a less reticulated costal ornamentation than *G. rhomboidalis*, yet as a related form it can be added to the species of *Glyptopleura* temporarily.

Cythere costata McCoy was placed in the genus *Glyptopleura* in 1927 by B. H. Harlton[5] from a study of the work of Jones & Kirkby[6].

Kirkbya plicata, Jones & Kirkby[7], *K. spinosa*, Jones & Kirkby[8], and *K. spiralis*, Jones & Kirkby[9] possess only a few longitudinal costae, yet because of the character of the articulation, the appearance of the overlap and the shape of the valves, are considered here as species of *Glyptopleura*.

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[1] Girty, G. H., Annals New York Acad. Sci. Vol. 20, No. 3, 1910, p. 234.

[2] Ibid., p. 236.

[3] Girty, G. H., U. S. Geol. Survey, Bull. 593, 1915, p. 136, pl. 11, fig. 3.

[4] Ulrich, E. O., Jour. Cincinnati Soc. Nat. Hist., Vol. 13, 1890-1891, p. 208, Pl. 28, fig. 3.

[5] Harlton, B. H., Jour. Pal., Vol. 1, No. 3, 1927, p. 206, pl. 32, fig. 8.

[6] Jones, T. R., and J. W. Kirkby, Ann. & Mag. Nat. Hist., Ser. 5, Vol. 15, 1885, p. 186, Figs. 13, 14, 15.

[7] Jones, T. R. & J. W. Kirkby, Trans. Geol. Soc. Glasgow, Vol. 2, 1868, p. 221.

[8] Ibid. p. 220.

[9] Jones, T. R. & J. W. Kirkby, Quart. Geol. Soc. London, Vol. 36, 1880, pp. 564, 568, 573, 588.

Kirkbya costata mooreana, Jones & Kirkby[10] is sufficiently distinguishable to be designated as a species of the *Glyptopleura.*

Kirkbya scotica, Jones & Kirkby[11] is so variable in size, shape, and ornamentations from the other species of *Glyptopleura* that it is only temporarily included in the list.

With the transfer of *K. spinosa* Jones & Kirkby to the genus *Glyptopleura,* the more recent specific name *G. spinosa* Harlton becomes a homonym[12]. *G. coryelli,* Harlton is proposed here for that species by B. H. Harlton[13].

Glyptopleura emarginata, Delo[14] is a new member of the genus added in 1930.

Other species described in the genus *Glyptopleura* include *G. texana,* Harlton, *G. menardensis,* Harlton, *G. salemensis,* Coryell & Brackmier, n. sp.

Two additional species described by Jones & Kirkby, *Kirkbya variabilis*[15] and *K. annectens*[16] which bear one or two simple costae, are rejected from consideration in relation to *Glyptopleura* since they are distinctly lobed and sulcated forms.

ORIENTATION OF THE VALVES

The genus *Glyptopleura* was first distinguished from the genus *Kirkbya* by the character of the overlaps of the valves. In the former the left valve is larger and overlaps the right, while the opposite order of overlap is apparently true in the latter. When considering valval overlap as well as in de-

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[10] Jones, T. R. & J. W. Kirby, Ann. & Mag. Nat. Hist., Ser. 5, Vol. 15, 1885, pl. 3, Fig. 15.

[11] Jones, T. R. & J. W. Kirkby, Trans. Geol. Soc. Glasgow, Vol. 2, p. 220, 1867.

[12] Proc. Biol. Soc. Washington, Vol. 39, 1926, Art. 35.

[13] Personal communication dated Mar. 17, 1931.

[14] Delo, D. M. Jour. Pal., Vol. 4, 1930, No. 2, p. 162, pl. 12, fig. 12.

[15] Kirkbya variabilis, Jones & Kirkby, Geol. Mag., Dec. 3, Vol. 3, 1886, p. 249, pl. 7, Figs. 4-8.

[16] Kirkbya annectens, Jones & Kirkby, Ann. and Mag. Nat. Hist., Ser. 5, Vol. 15, 1885, p. 183, pl. 3, Fig. 7.

scribing the surface ornamentation, an agreement in orientation is of primary importance. It is of particular interest here since several species described in the *Kirkbya* genus are transferred to the *Glyptopleura* genus.

In 1885 Jones & Kirkby[17] considered the higher, truncated, and more projecting end as the posterior and the lower, more rounded end as the anterior in their descriptions and figures of *K. plicata, K. spinosa,* and *K. costata.*

In 1886 the same authors[18] redescribed *K. plicata,* and called attention to the reversal in orientation in an accompanying note.

In their earlier orientation, the costae on the species mentioned above cross the valves obliquely, rising upward towards the anterior end. This position seems to be the better biological arrangement for forward movement, and a survey of the longitudinally costated forms shows that the character is a constant feature among the older species of *Kirkbya* that are here added to *Glyptopleura* as well as the recently described species of the latter genus. The overlap of the valves of the species described and figured by Jones & Kirkby as members of the genus *Kirkbya* fulfill the requirement stated by Girty in the generic description.

When using this orientation, the anterior end, in some forms is thicker and more inflated as stated by Girty in the description of *G. inopinata.*

GENERIC AND SPECIFIC DESCRIPTION

Family *Glyplopleuridae* Girty 1910.

Glyptopleurdidae Girty, Ann., New York Acad. Sci., Vol. 20, 1910, No. 3, p. 234.

Genus *Glyptopleura* Girty 1910.

Glyptopleura Girty, Ann., New York Acad. Sci., Vol. 20, 1910. No. 3, p. 236.

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[17] Jones, T. R. & J. W. Kirkby, Ann. & Mag. Nat. Hist., Ser. 5, Vol. 15, 1885, pp. 184-187, pl. 3.

[18] Jones, T. R. & J. W. Kirkby, Geol. Mag., Dec. 3, Vol. 3, 1886, p. 249, pl. 7, Fig. 1-3.

Genotype: *Glyptopleura inopinata* Girty.

Original description: Shell rather small, subquadrate, with a backward swing, the posterior end being higher than the anterior end and somewhat truncated; inequivalve the left valve is much larger and overlaps the other all around save where along the distinct straight hinge line, there is a subcentral pit. The surface is marked by inosculating costae.

Girty follows the earlier orientation of Jones and Kirkby. The hinge line is straight with simple articulation projections at each extremity. The ornamentation consists of few to several longitudinal costae that vary considerably in obliquity, curvature, inosculations and size.

Range: Carboniferous; England, Scotland, Mississippi Valley.

Glyptopleura inopinata Girty 1910[19].

Glyptopleura inopinata Girty, Annals New York Acad. Sci., Vol. 20, No. 3, p. 237.

Description: Small, subquadrate, unequivalved ostracode, with left valve overlapping the right on the entire free margin The hinge line is straight with the left valve overlapping the right near the cardinal extremities forming tooth like projections. The posterior margin is obliquely truncated dorsally, the anterior is acutely rounded. The anterior half of the valve is more inflated than the posterior, a circular pit occurs slightly dorsal of and posterior to the center; prominent curved, inosculating, obliquely longitudinal costae ornament the surface of the valve; a finely straited surface borders the free margin.

Horizon and Locality: Fayetteville shale, Arkansas.

Glyptopleura angulata Girty 1910[20].

Glyptopleura angulata Girty, Ann., New York Acad. Sci., Vol. 20, 1910, No. 3, p. 237.

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[19] The senior author checked the above description by personal study of the genotype, for which opportunity he is indebted to Dr. P. V. Roundy.

[20] The note under *G. inopinata* applies to this species also.

Description: Small, subovate, unequivalved ostracode with straight hinge line, and rounded cardinal angles; the anterior margin is narrowly rounded, the posterior margin broadly and regularly curved; the ventral margin extends obliquely towards the posterior making the anterior height distinctly less than posterior. The surface is ornamented with a few angular inosculating, longitudinal costae that trend from the cardinal anterior margin towards the posterior ventral curvature; the median costa lies upon the oblique ridge that marks the greatest convexity of the valves; it rises into a small projection at its anterior end. A pit lies slightly posterior to the center of the valve and above the prominent median costa.

Horizon and Locality: Fayetteville shale, Arkansas.

Glyptopleura costata (*McCoy*) 1844

Plate I., Fig. 1-1b, 2, 2a, 3, 3a; 4, 4a, var.

Cythere costata McCoy, Synopsis Char. Carb. Foss. Ireland. 1844, p. 165, pl. 23, fig. 11.

Kirkbya costata Jones & Kirkby, Ann. & Mag. Nat. Hist., Ser. 3, Vol. 18, 1886, p. 43; Jones, Kirkby and Brady, Monogr. Brit. Foss. Bivalved Entom., Paleontogr. Soc., 1884, p. 89, pl. 7, fig. 17, Jones & Kirkby, Ann. & Mag. Nat. Hist., Ser. 5, Vol. 15, 1885, p. 186, pl. 3, fig. 13, 14, var. fig. 15.

Kirkbya (*? Barychilina*) *costata* Ulrich, Jour. Cincinnati Soc. Nat. Hist., Vol. 13, 1891, p. 208, pl. 18, fig. 2a, 2b.

Glyptopleura costata Harlton, Jour. Pal. Vol. 1, No. 3, 1927, p. 206, pl. 32, fig. 8.

Description: Carapace, short, thick, subquadrate, unequivalved, with the left valve, larger overlapping the right on the entire free margin; the hinge line is straight with a simple external tooth-like articulation process formed by the overlapping valve at the cardinal extremities; the ventral border is convex, the posterior end is high, truncated and somewhat projecting, the anterior end is lower, rounded below and angular above, a circular pit is located posteriorly and slightly above the center; the flattened surface is ornamented with

several (eight to ten) strong variably inosculating costae that cross the valve obliquely from the posterior ventral area toward the anterior dorsal angle; the posterior end of the costal ribs unite, but the anterior ends are free; the median ribh are broken at the margin of the central pit. A narrow rim bounds the margin of the valve, becoming less prominent dorsally and anteriorly.

Length, 1.2 mm. Height 0.8 mm., Thickness 0.5 mm.

Horizon and *Locality:* Carboniferous limestone, England. Salem limestone, Indiana.

Glyptopleura plicata (Jones & Kirkby) 1867

Plate I., Fig. 7-7b, Plate II., 8, 9, 9a.

Kirkbya plicata Jones & Kirkby, Trans. Geol. Soc. Glasgow, Vol. 3, 1867, p. 221; Vol. 3, 1871, Suppl. p. 28, Armstrong and others, Catalog W. Scot. Fossils, 1876, p. 45; Kirkby, Quart. Jour. Geol. Soc. London, Vol. 36, 1880, p. 588. Jones & Kirkby, Ann. & Mag. Nat. Hist., Ser. 5, Vol. 15, 1885, p. 186, pl. 3, fig. 9, 10. Jones & Kirkby, Geol. Mag., Dec. 3, Vol. 3, 1886, p. 250, pl. 7, fig. 1, 2, 3.

Description: Carpace short, subovate, unequivalved, with the left valve larger and overlapping the right; the dorsal margin straight, a simple external tooth-like projection on the left valve at the cardinal extremities; the ventral margin convex; anterior end rounded and less projecting, less in height but more inflated than the posterior; a median pit occurs slightly posterior of the center of the valve; a narrow prominent rim borders the free margin and less conspicuously along the terminals of the hinge margin; two strong costae cross the valve obliquely from their point of junction near the posterior-ventral margin to the antero-dorsal portion, where they approach close together but the ends remain free, a shorter third rib may be present just above the ventral margin.

Length 0.8 mm. Height 0.5 mm. Thickness 0.4 mm.

Horizon and Locality: Carboniferous limestone, England. Salem limestone, Indiana.

Glyptopleura **salemensis** Coryell & Brackmier n. sp. 1931
Plate I., Fig. 6.

Description: Carapace subovate, short, compressed, with the greatest thickness in the postero-dorsal portion; dorsal margin straight; anterior end rounded; posterior end higher than anterior and more broadly rounded; a deep pit lies above and anterior of center of the valve; a single longitudinal rib crosses the middle of the valve; a continuous rib paralleling the margin encloses an area in which the pit and central rib occur; surface smooth.

Length 1 mm. Height 0.6 mm.

Horizon and *Locality:* Salem limestone, Bloomington, Indiana.

This species differs from *G. spirilis* (Jones and Kirkby) in the arrangement of the marginal rib, and a narrowly rounded posterior marginal outline in the latter species.

Glyptopleura **guardia** Coryell & Brackmier n. sp.
Plate I., Figs. 5, 5a.

Kirkbya costata Jones and Kirkby, Ann & Mag. Nat. Hist., Ser. 5, Vol. 15, 1885, pl. 3, fig. 14a, 14b.

The specimen figured by Jones and Kennedy as *Kirkbya costata* and referred to above is very distinctly different from the type of the species as figured by McCoy as *Cythere costata* in the "Synopsis of the characters of the Carboniferous Fossils of Ireland" and also different from the plesiotypes of *Glyptopleura costata* of the authors. (Plate I.). Jones and Kirkby species is here identified as a new species of *Glyptopleura.*

It differs from the other described *Glyptopleura* species in that the lateral pit is located near the central anterior border within the costated area.

The type was collected from the Carboniferous limestone at Steeraway, England.

Glyptopleura **coryelli** Harlton, new name[21] 1931.
Plate II., Fig. 18.

Glyptopleura spinosa Harlton, University Texas Bull. 2901, 1929, p. 148, pl. 1, fig. 18. Delo, Jour. Pal., Vol. 4, 1930, No. 2, p. 162, pl. 12, fig. 12.

Description: Carapace subquadrate, short and thick; dorsal margin straight; terminal margins rounded, the anterior more narrowly rounded than the posterior; the lateral pit is situated slightly posterior to the center; the surface is longitudinally costated with the ribs rising dorsally towards the anterior and terminating with free spine like ends at the border of a relatively smooth anterior marginal area; the median costa is interpreted by the central pit; a short rib is interculated between the longer ones in the posterior dorsal quarter.

Length. 1 mm. Height 0.58 mm. Thickness 0.5 mm.

Holotype, U. S. N. M. No. 80566.

Horizon and *Locality:* Middle to lower Canyon limestone, Pennsylvanian, 3 miles north of Hext, Menard County, Texas.

Glyptopleura spinosa (Jones and Kirby) 1867.
Plate II., Fig. 10, 10a.

Kirkbya spinosa Jones and Kirby, Trans. Geol. Soc. Glasgow, Vol. 2, 1867, p. 220; Vol. 3, suppl. p. 29. Armstrong and others, Catal. W. Scot. Fossils, 1876, p. 45. Jones and Kirkby, Ann. & Mag. Nat. Hist., Ser. 5, Vol. 15, 1885, p. 185, pl. 3, Fig. 12, a-b.

Description: Carapace short, hinge line straight, greatest thickness anterior; ventral margin convex; anterior margin rounded somewhat truncated ventrally; posterior margin narrowly curved ventrally and dorsally giving a prominent ventral backward swing; the subcentral pit is in some specimens somewhat elongate longitudinally or transverse; two or three costae traverse the valves longitudinally, the upper one

[21] The following communication was received from Mr. Bruce H. Harlton March 17, 1931:—"Dr. H. N. Coryell in his re-classification of *Glyptopleura* discovered that the name *G. spinosa* is a homonym. I herewith propose the new name *G. coryelli* for *G. spinosa* as described in the University of Texas Bull. 2901, 1929, p. 148."

either above or across the pit, the anterior ends curve dorsally and end in spines; free margin bordered by narrow rim.

Length 1 mm.

Horizon and Locality: Carboniferous limestone, England and Scotland.

Glyptopleura spiralis (Jones and Kirkby) 1880
Plate II., Fig. 11, 11a.

Kirkbya spiralis Jones and Kirkby, Quart. Jour. Geol. Soc. London, Vol. 36, 1880, p. 564, 573, 588. Jones, Proc. Berwickshire Nat. Club, Vol. 10, 1884, p. 323, pl. 2, fig. 12, 13, Jones and Kirkby, Ann. and Mag. Nat. Hist., Ser. 5, Vol. 15, 1885, p. 184, pl. 3, fig. 11a, b.

Description*:* Carapace short, compressed, hinge line straight, greatest height in posterior third; ventral margin concave; posterior and anterior margins rounded; the subcentral pit is in the posterior dorsal quarter; the free margin is bordered by a narrow ridge which unites with the lateral costal rib near the anterior cardinal extremity; the surface ornamentation consists of two costae, one that trends downward towards the posterior near which it curves ventrally, paralleling the free margin to the mid anterior where it curves backward toward the subcentral pit, the other lies below the median longitudinal line as downwardly a curved ridge.

Length 1.14 mm.

Horizon and Locality: Carboniferous of England. Calciferous sandstone, Scotland.

Glyptopleura mooreana (Jones and Kirkby) 1885
Plate II., Fig. 15.

Kirkbya costata var. *mooreana* Jones and Kirkby, Ann. and Mag. Nat. Hist., Ser. 5, Vol. 15, 1885, p. 187, pl. 3, fig. 15.

Description: Carapace small, short, subquadrate; hinge line straight; extremities rounded, the posterior higher and more projecting than the anterior; ventral margin nearly straight; subcentral pit, elongate, deep, slightly posterior and dorsal of the center; a ridge borders the entire margin; a series of five longitudinal costae with terminals joined and

the entire group connected by a ridge to the anterior marginal rim slightly above the middle.

Horizon and Locality: Lower Carboniferous, England, Calciferous sandstone, Scotland.

This species, although smaller, seems to be somewhat related to *Glyptopleura spiralis* in arrangement of its ornamentation.

The authors consider the characteristic of *G. mooreana* to be of specific rank.

Glyptopleura texana Harlton, 1929.
Plate II., Fig. 17, 17a.

Glyptopleura texana Harlton, University Texas, Bull. 2901, 1929, p. 148, pl. 1, fig. 17a, b.

Description: Carapace subquadrate and thick; hinge line straight; end rounded the posterior more regular than the anterior; the subcentral pit is slightly dorsal and posterior to the center; the surface is ornamented with several coarse ribs that trend longitudinally across the valve in an antero-dorsal to a portero-ventral direction; the shorter ribs occur in the posterior-dorsal and antero-ventral portions of the valves; a ridge borders the entire margin.

Length 1 mm. Height, 1.56 mm. Thickness, 1.5 mm.

Holotype, U. S. N. M. N. 80565.

Horizon and Locality: Middle to lower Canyon limestone, Pennsylvanian, Menard County, Texas.

Glyptopleura menardensis Harlton 1929
Plate II., Fig. 12, a, b.

Glyptopleura menardensis Harlton, University Texas, Bull. 3901, 1929, p. 149, pl. 2, fig. 1a-c.

Description: Carapace subquadrate, straight hinge line, and strongly ribbed; extremities rounded; ventral margin convex; subcentral pit slightly above and posterior of the middle; the entire margin is bordered with a ridge; the longitudinal costae merge into the marginal ridge along the posterior edge; two alternate medial ribs are joined anteriorly; the dorsal rib is broken.

Length, 1 mm. Height, 1.56 mm. Thickness, 1.48 mm.

Cotypes, U. S. N. M. No. 80567.

Horizon and Locality: Upper Canyon limestone, Pennsylvania, four miles west of Hext, Menard County, Texas.

Glyptopleura scotica (Jones and Kirkby) 1867
Plate II., Fig. 13.

Kirkbya scotica, Jones and Kirkby, Trans. Geol. Soc. Glasgow, Vol. 2, 1867, p. 221; Ibid. Vol. 3, 1871, Suppl. p. 28. Armstrong and others, Catal. W. Scotland Fossils, 1876, p. 45. Jones and Kirkby, Ann. and Mag. Nat. Hist., Ser. 5, Vol. 15, 1885, p. 187, pl. 3, figs. 16, 17.

Description: Carapace small, compressed, short; greatest height nearly central; hinge line straight; extremities round, the posterior more extended than anterior, forming a distinct backward swing; a pit present near the center of the valve; longitudinal ribs unite at the ends.

Length, 0.71 mm.

Glyptopleura venosa (Ulrich) 1891
Plate II., Fig. 14.

Kirkbya venosa Ulrich, Jour. Cincinnati Soc. Nat. Hist., Vol. 13, 1891, p. 208, pl. 18, fig. 3.

Description: Carapace small, subelliptical hinge line straight; anterior and posterior ends regularly curved; ventral margin slightly convex; free margin bordered by a concave area; rather wide at the ends and narrowly ventrally; central convexity of the valve ornamented by curved, longitudinal narrow ridges; pit slightly dorsal of the middle; surface finely reticulate.

Length 0.75 mm. Height 0.48 mm.

Horizon and Locality: Shaly limestone of the Chester group near Grayson Springs, Kentucky.

This species differs from the other species of the genus *Glyptopleura* in the finely reticulate surface and concave marginal rim. In the majority of species of this genus the surface is costate and the margin bordered by a ridge or without any ornamentation.

Glyptopleura (?) *rhomboidalis* Girty 1915.
Plate II., Fig. 16.

Glyptopleura rhomboidalis Girty, U. S. Geol. Surv. Bull. 593, 1915, p. 136, pl. 11, fig. 3.

Description: Carapace small rhomboidal, hinge line straight; anterior margin truncated ventrally; posterior margin flattened dorsally forming a distinct appearance of a backward ventral extension; ventral margin slightly convex; a marginal groove and border ornaments the free edge; the convexity of the valve is marked by a number of anastomosing ridges that forms a coarse network over the surface; the central pit if present is difficult to locate positively.

Length 0.76 mm. Height 0.42 mm.

Horizon and Locality: Batesville sandstone, Round Mountain, Arkansas.

This species varies greatly from any of the others in the complexity of its coarse reticulation, and it is here only provisionally included in the *Glyptopleura.*

Glyptopleura emarginata Delo 1930.
Plate II., Fig. 19.

Glyptopleura emarginata Delo, Jour. Paleo., Vol. 4, 1930. No. 2, p. 163, pl. 12, fig. 13.

Description: Carapace inequivalved, small, subquadrate; hinge line straight; greatest height posterior of center; posterior margin curved, somewhat truncated dorsally, giving emphasis to the postero-ventral backward swing; the anterior margin more broadly curved ventrally; ventral margin convex; the convexity of each valve is ornamented by three longitudinal antero-ventral ribs, with a shorter one in the dorsal posterior and another antero-ventrally located; the subcentral pit lies below the upper long ridge and dorsal of the center; the entire margin is bordered by a smooth rib that unites with the marginal extremities of all the ridges except the short ventral one.

Length 0.80 mm. Height 1.56 mm. Thickness 1.5 mm.

Horizon and Locality: Upper Carboniferous, Transconti-

nental Oil Co., Blackstone-Slaughter No. 1, Blk. 129, Sec. 29, T. & St. L. Survey; 250 feet from S. and 1250 from W. lines, Elevation 3635 feet. Depth 1365 — 75 feet. Shale Basin, Pecos County, Texas.

Columbia University, New York.

EXPLANATION OF PLATE I.

Fig. 1, 1 b. Glyptopleura costata (McCoy) x 25
Fig. 1. - Right valve. Fig. 1 a. - Dorsal view. Fig. 1 b. - Ventral view. Salem limestone, Bloomington, Ind.

Fig. 2, 2 a. Glyptopleura costata (McCoy) x 20
(After Ulrich, 1891.) Fig. 2. - Left valve. Fig. 2 a. - Edge view. Warsaw. Columbia, Ill.

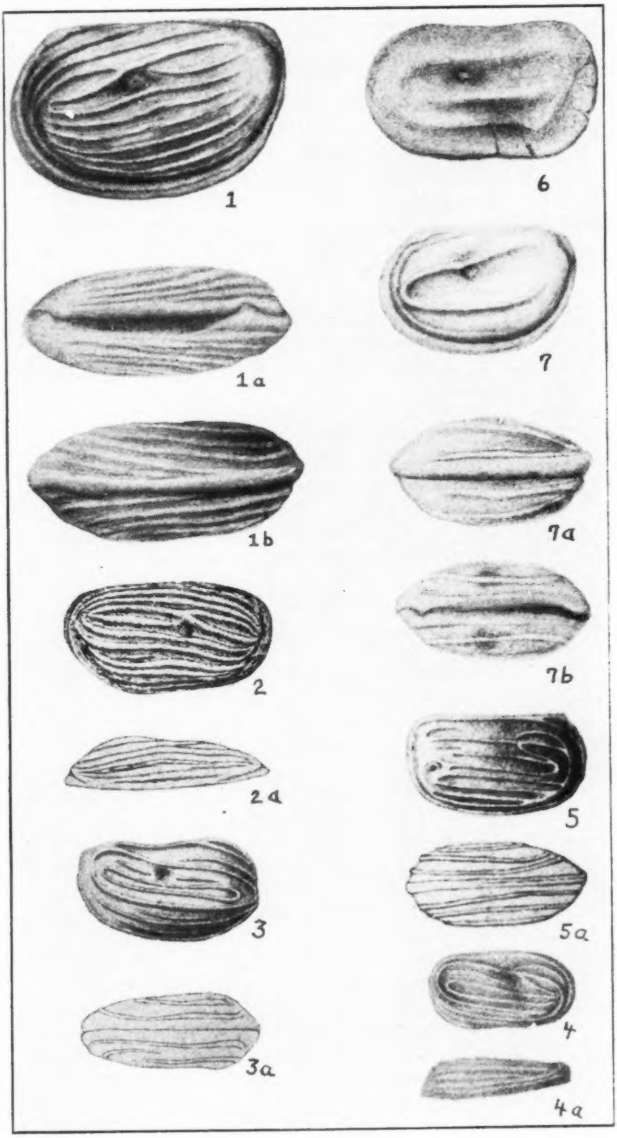
Fig. 3, 3 a. Glyptopleura costata (McCoy) x 20
(After Jones and Kirby, 1885.) Fig. 3. - Left valve. Fig. 3 a. - Dorsal view. Carboniferous limestone, Cam Creek, England.

Fig. 4, 4 a. Glyptopleura costata (McCoy) x 20
(After Jones, Kirby and Brady, 1884), a variety. Fig. 4. - Right valve. Fig. 4 a. - Edge view. Carboniferous limestone, Brockley, Lanarkshire, England.

Fig. 5, 5 a. Glyptopleura guardia Coryell and Brackmier, new name, x 25 (After Jones and Kirby, 1885.) Fig. 5. - Left valve. Fig. 5. - Ventral view. Carboniferous limestone, Steeraway, England.

Fig. 6. Glyptopleura salemensis Coryell and Brackmier, n. sp. x 35. Left valve. Salem limestone, Bloomington, Ind.

Fig. 7, –7 b. Glyptopleura plicata (Jones and Kirby) x 35
Fig. 7. - Right valve. Fig. 7 a. - Ventral view. Fig. 7 b. - Dorsal view. Salem limestone, Bloomington, Ind.


1
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1b
7a
7b
2
2a
5
3
5a
4
3a
4a

EXPLANATION OF PLATE II.

Fig. 8. Glyptopleura plicata (Jones and Kirby) x 20
(After Jones and Kirby, 1885.) Right valve. Carboniferous limestone, Western super Mare, England.

Fig. 9, 9 a. Glyptopleura plicata (Jones and Kirby) x 20
(After Jones and Kirby, 1885.) Fig. 9. - Left valve. Fig. 9 a. - Edge view. Carboniferous limestone, Randerstone, England.

Fig. 10, 10 a. Glyptopleura spinosa (Jones and Kirby) x 20
(After Jones and Kirby, 1885.) Fig. 10. - Right valve. Fig. 10 a. - Ventral view. Carboniferous limestone, Claigenglen, England.

Fig. 11, 11 a. Glyptopleura spiralis (Jones and Kirby) x 20
(After Jones and Kirby, 1885.) Fig. 11. - Right valve. Fig. 11 a. - Ventral view. Carboniferous limestone, Randerstone, England.

Fig. 12, 12 b. Glyptopleura menardensis (Harlton) x 15
(After Harlton, 1929.) Fig. 12. - Right valve. Fig. 12 a. - Left valve. Fig. 12 b. - Dorsal view. Canyon formation, Menard County, Texas.

Fig. 13. Glyptopleura scotica (Jones and Kirby) x 25
(After Jones and Kirby, 1885.) Right valve, anterior end upward. Carboniferous limestone, Linlithgow Bridge, Scotland.

Fig. 14. Glyptopleura (?) venosa (Ulrich) x 20
(After Ulrich, 1891.) Right valve. Chester, Grayson Springs, Ky.

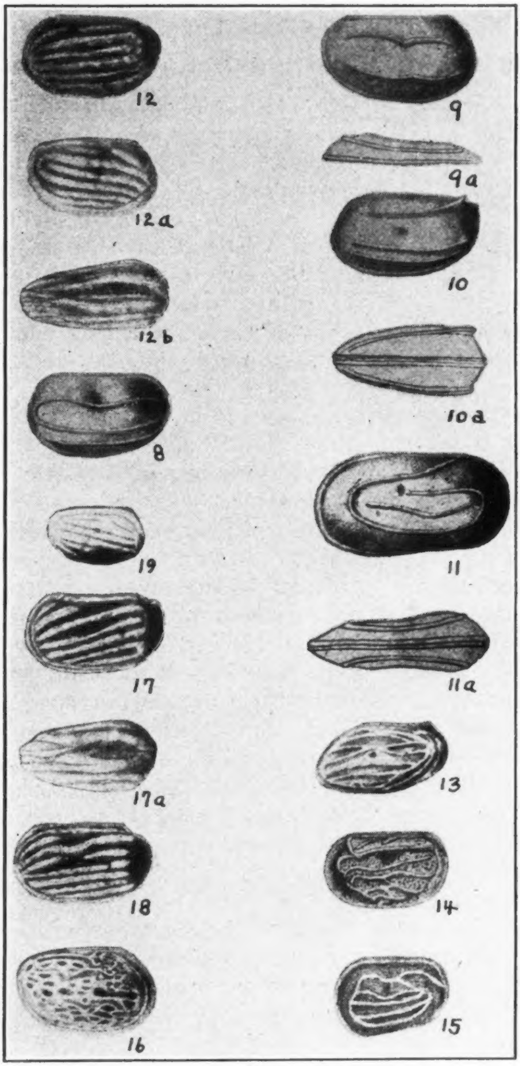
Fig. 15. Glyptopleura mooreana (Jones and Kirby) x 20
(After Jones and Kirby, 1885.) Right valve. Carboniferous limestone, Weston super Mare, England.

Fig. 16. Glyptopleura (?) rhomboidalis (Girty) x 20
(After Girty, 1915.) Left valve. Batesville sandstone, Round Mountain, Ark.

Fig. 17, 17 a. Glyptopleura texana (Harlton) x 20
(After Harlton, 1929.) Fig. 17. - Right valve. Fig. 17 a. - Dorsal view. Canyon formation, Menard County, Texas.

Fig. 18. Glyptopleura coryelli (Harlton), new name, x 20
(After Harlton, 1929.) Right valve. Canyon formation, Menard County, Texas.

Fig. 19. Glyptopleura emarginata (Delo) x 18
(After Delo.) Left valve. Transcontinental Oil Co., Blackstone Slaughter No. 1, Blk. 129, Sec. 29, T. & St. L. Survey: 250 ft. from S. and 1250 ft. from W. Lines, Elevation 3,636 ft., depth 1365-75 ft. Upper Carboniferous, Pecos County, Texas.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SOME SNAIL BORINGS OF PALEOZOIC AGE

CARROLL LANE FENTON AND MILDRED ADAMS FENTON

The activities of several genera of existing marine snails, which prey upon other animals by boring through their shells, are well known. *Urosalpinx*, the oyster drill, by concentrating its efforts upon sessile pelecypods cultivated by man, has assumed economic importance by virtue of this habit. *Polynices* or *Natica*, the moon snails, bore extensively in *Venus* and *Mya*, pelecypods also valued as human food; though with characteristic rapacity they devour their own kind with apparently equal readiness.

Casual examination of any large collection of Cenozoic and later Mesozoic molluscs show that the boring, predaceous habit is not a recent acquisition—nor is it restricted to the genera that have been mentioned, even though *Polynices* is its outstanding American exponent. In the case of some Cenozoic species, cannibalism seems to have been even more pronounced than it is today. In the Cretaceous, shells similarly bored are common, especially in formations which bear abundant species of the Naticoid genus *Gyrodes*.

In both Mesozoic and Cenozoic, it is the pelecypods which are the chief victims of the rapacious univalves, with gastropods a rather poor second. The sessile brachiopods are less often bored: partly because they are less abundant than molluscs in most of the formations involved; partly because their habitats do not closely coincide with those of the borers; and partly (perhaps) because the amount of food supplied by a brachiopod is small compared with that afforded by a clam of equivalent size.

In the Paleozoic, however, the situation was otherwise. Brachiopods were common in shallow-water faunas—even those like the Oriskany, which are preserved in sandstone. In many, if not most formations, brachiopods also exceeded

pelecypods in abundance and even in size. The contrast may be exaggerated by the fact that Paleozoic pelecypods commonly are mere casts or internal molds, and so would fail to show borings which might have existed in the shells. Yet at most this is an exaggeration, and it seems necessary to conclude that brachiopods were the chief prey of Paleozoic snails.

In a measure, this is borne out by the few accounts and illustrations which deal with the activities of the latter organisms. Clarke,[1] for example, figures three perforated brachiopods: *Spirifer medialis* Hall, of the Hamilton; *Meristella* sp. of the Oriskany; and *Spirifer granulosus* Conrad, also of the Hamilton. In all the holes seem to be of unquestionably molluscan origin, though two of them fail to show the beveled edges so characteristic of the borings made by the living *Polynices*. The third, however, is broadly beveled and probably represents the activity of a snail specifically or even generically distinct from the one which produced the nonbeveled perforations.

These two types may be found among all Paleozoic borings that have come to hand. In the Cincinnatian, one has been noted which possesses beveled edges; in the Richmond, where borings first are common, both types are to be found. In the Hamilton of western New York both types also occur, as they do in the Traverse of Michigan. Plate I illustrates borings from the Richmond and Traverse; Fig. 1 in the text shows others from scattered formations.

The Silica Shale of Lucas County, Ohio, (also of Hamilton age) has afforded two bored shells of *Leptostrophia perplana* (Conrad) which are unusual. In both specimens, the borings are beveled within as well as without; in one, there is a single incomplete perforation upon the inner surface of the pedicle valve. The margins of this perforation are sharp, but the shell around it is eroded. The other specimen, a brachial valve, bears five perforations whose general character agrees with that of the single incomplete one.

[1] N. Y. State Mus., 61st. Ann. Rep., vol. 1, pl. 12, figs. 5-7, 1908.

These borings are not definitely assigned to snails, though they probably are the work of those organisms. But why a snail should bore upon the inside of a dead shell, and why it should bevel both outer and inner edges of a perforation are points by no means clear.

In the Devonian of Iowa, sponge borings (relatively uncommon in the East) outnumber those of annelids and snails. A specimen of *Atrypa inflata* Webster, from the State Quarry formation near Solon, Iowa, shows an irregular, beveled boring near the lingual extension. Numerous specimens belonging to the *Spirifer varians* gens of the Hackberry show small borings, without bevel, which most commonly occur in or near the sinus. Two examples are illustrated; others may be seen in Plate 26, Fig. 5, and Plate 29, Fig. 5, of the senior author's *Studies of Evolution in the Genus Spirifer*.[2] In the former of these the boring is incomplete, failing to penetrate more than half the thickness of the shell—a feature shown also in one of the New York specimens illustrated by Clarke. Several of the members of the *S. hungerfordi* gens also show borings, though only in small specimens.

The identity of the snails which have made these borings is of necessity uncertain. In the Cincinnatian and Richmond, especially, gastropods are too numerous and varied, and borings too few, to allow speculation upon relationships. In the Hackberry there are numerous gastropods, but from the size of the borings and their stratigraphic occurrence, *Diaphorostoma* and *Straparollus* seem most likely as their makers. Of these, both relationships and shell-form suggest the former.

In the Hamilton of New York and the Traverse of Michigan, relationships are less obscure. In both formations, bored shells are associated with two dominant genera of gastropods: *Diaphorostoma*—of the group of *D. lineata* (Conrad) —and *Platyceras* spp. Both are members of the family Capulidae, which in the familiar Zittel-Eastman classification,

[2] Pub. Wagner Free Inst. Science, vol. 2, 1931.

sponsored by Pilsbry, immediately precedes the *Naticidae*,—of which the predatory moon snails are the most familiar living examples.

In the taxonomic position, therefore, both *Diaphorostoma* and *Platyceras* are possible borers; and in the faunas just mentioned it seems clear that one or both possessed the boring habit. Against *Platyceras*, however, it may be argued that at least from the Silurian onward, members of the genus were commensal upon crinoids—with whose remains the Traverse and Hamilton species are associated. Clarke[3] and Keyes[4] have emphasized this relationship, illustrating commensal Platycerids of Silurian, Devonian and Mississippian age. In contrast, Clarke mentions only two specimens of *Diaphorostoma* (*Platyostoma*) which lie upon the tegmens of crinoids.

It seems, therefore, that known habits of feeding argue against the opinion that *Platyceras* may have been a borer. On the other hand, it is not inconceivable that some species may have adopted the boring habit, while others became commensal. If Clarke's figures and interpretation are valid, this occurred in *Diaphorostoma*, a nearly related genus. In this connection, the two types of boring in faunas containing both genera may possess significance.

Therefore, while inclined to stress the genus *Diaphorostoma* as a boring mollusc in Devonian faunas, we think that it may have shared its habit with some species of *Platyceras* which never had become completely commensal. That such borings are common in brachiopods seems to be a consequence of the distribution and abundance of those organisms in Paleozoic seas. The following list shows the distribution, in stratigraphy, of the bored brachiopods that have come to our attention:

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[3] N. Y. State Mus. Bull. 221-222, pp. 68-78, 1921.
[4] Proc. Am. Phil. Soc., vol. 25, pp. 231-248, 1888.

Hackberry:	*Spirifer* spp., *S. varians* gens.
	Spirifer spp., *S. hungerfordi* gens.
State Quarry:	*Atrypa inflata* Webster
Traverse:	*Stropheodonta erratica* Winchell
	Spirifer aff. *euryteines* Owen
	Atrypa petosequa F. and F.
Hamilton:	*Rhipidomella* sp.
	Leptostrophia perplana (Conrad)
	Spirifer medialis Hall
	Spirifer granulosus Conrad
	Parazyga hirsuta Hall
	Atrypa "reticularis" (Linnaeus)
Oriskany:	*Meristella* sp.
Richmond:	*Sowerbyella rugosa clarksvillensis* (Foerste)
	Rafinesquina cf. *alternata* (Emmons)
	Dalmanella meeki (Miller)
	Platystrophia acutilirata (Conrad)
Cincinnatian:	*Platystrophia* sp.

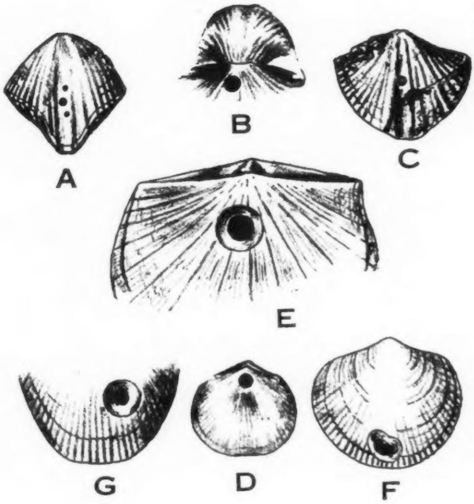

Fig. 1. Paleozoic brachipods bored into by snails. B, *Parazyga hirsuta* Hall, Hamilton of western New York. A&C, *Spirifer* spp. of the *varians* gens, Hackberry of northern Iowa. D, *Rhipidomella* sp., Hamilton of Eighteen Mile Creek, New York. E, *Rafinesquina* cf. *alternata* (Emmons), Waynesville near Weisburg, Indiana. F, *Atrypa* sp., Hamilton near East Alexander, New York. G, *Atrypa inflata* Webster, State Quarry formation near Solon, Iowa. In figures A-D, the perforations are not beveled; in E-G, beveling is marked. Specimens in the Carnegie Museum, Pittsburgh; all figures x 1.

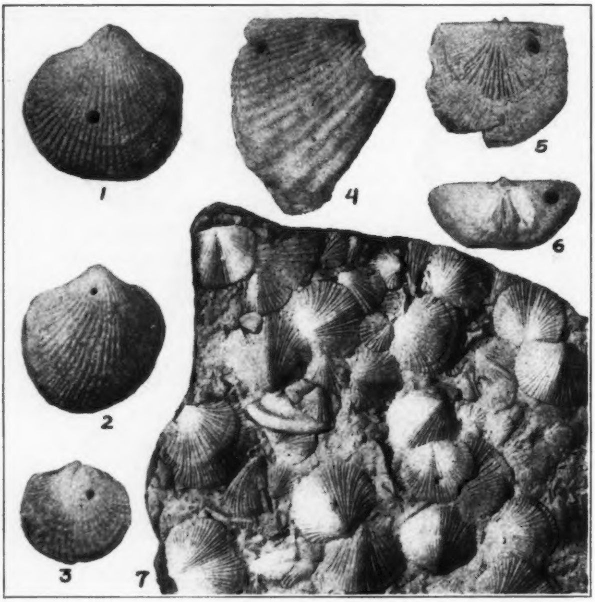

PLATE 1

FIGURES

1–3. *Atrypa petosequa* Fenton and Fenton. The holotype and two metatypes, showing perforations upon the pedicle valve. Traverse, near Bay Shore, Michigan.

4. *Spirifer* aff. *eurytcines* Owen. Fragment of brachial valve, with beveled perforation. Traverse, near Bay Shore, Michigan.

5. *Stropheodonta erratica* Winchell. Brachial valve, with beveled perforation. Traverse, near Bay Shore, Michigan.

6. *Sowerbyella rugosa clarksvillensis* (Foerste). Specimen with a large, beveled perforation. Waynesville, eastern Indiana.

7. *Dalmanella meeki* (Miller). Part of a slab bearing one specimen with non-beveled perforation. Waynesville, eastern Indiana.

(Specimens of Fig. 1, University of Cincinnati Museum; Figs. 6-7, Buffalo Museum of Science; others in the Carnegie Museum.)

TWO NEW RECORDS OF THE PLEISTOCENE BEAVER, CASTOROIDES OHIOENSIS

WILLIAM L. ENGELS

Among a small collection of Pleistocene mammal remains in the exhibits of the Museum of the Northern Indiana Historical Society, at South Bend, Indiana, are two specimens of the extinct Beaver, *Castoroides ohioensis*, which as yet have not been recorded. One provides a sixth record of this species for Michigan (a second record for Berrien County); the other brings the total of recorded Indiana specimens to thirteen, and is the first known from St. Joseph County. This report presents a brief description of each specimen.

1. Catalogue no. 1195, Mus. North. Ind. Hist. Soc. Well-preserved skull of *Castoroides ohioensis* but with the mandibles lost, both zygomatic arches missing, and the facial portions of the maxillae broken away; dental series complete and in good condition. (Fig. 2 and 3). "From the Dowagiac river valley, Niles Township, Berrien County, Michigan, two miles northeast of Niles, Michigan." For purposes of comparison with other known specimens the following measurements are given:

Length, tip of nasals to supra-occoiptal crest	260 mm.
Height, perpendicular to first molar	107 mm.
Height, occipital portion	67 mm.
Width, just above foramen magnum	140 mm.
Narrowest width of dorsum of skull	58 mm.
Width of foramen magnum	31 mm.
Height of foramen magnum	20 mm.
Greatest length of nasals	100 mm.
Greatest width of nasals	32 mm.
Length of palate in mid-line	195 mm.
Distance between post. borders of first molars	22 mm.
Distance between post. borders of last molars	61 mm.
Length of diastema	120 mm.

Length of premolar-molar series	70 mm.
Length of exposed incisor, along outer surface	110 mm.

The skull was found just north of Niles, Michigan, during the process of some excavations which were being made by the Michigan Central Railroad. No details as to depth or character of the soil are available. The skull was purchased for the Northern Indiana Historical Society by a group of South Bend citizens, including Dr. H. T. Montgomery and Mr. B. C. Stephenson.

Castoroides ohioensis has already been recorded from Berrien County (by O. P. Hay: a skull in the American Museum of Natural History formerly owned by Mr. George A. Baker of South Bend, Indiana). Single specimens are known from Lenawee, Washtenaw, Lapeer, and Shiawassee counties in Michigan.

2. Peculiar conditions attend the first recording of the Giant Beaver in St. Joseph County, Indiana. In the Northern Indiana Historical Society's collection is a photograph of an *Castoroides* incisor, marked: "Recently found in St. Joseph County (1896)". (Fig. 1. See explanation, p. 531). When and how the Society came into possession of the photograph the author was unable to learn, since through some oversight it had not been catalogued. The Mr. Baker, whose name appears in the inscription is apparently the same from whom the American Museum obtained the first Berrien County *Castoroides* skull. The question of the fate of the tooth from which the photograph was made is confusing. In the exhibit case with the Michigan skull described above the author found a single incisor, without mark or label of any kind. The attendant was unable to furnish any information as to its history. A comparison of this tooth with the one in the photograph would lead one to suspect they were one and the same—the marks of fracture are identical in each. The supposition is strengthened by the fact that Dr. H. T. Montgomery of South Bend, long intimately associated with the Museum, is quite certain the tooth is Mr. Baker's St. Joseph

County specimen. This tooth measures about 220 mm. in length, along the outside surface, and has a circumference of 92 mm. at a point 65 mm, from the tip. The Michigan specimen described above has upper incisors only 77 mm. in circumference, measured at the same point. The specimen is a lower incisor, as is the one in the photograph, although it is labeled "right upper incisor."

Though the identity of the tooth remain merely a supposition, the photograph affords sufficient basis for recording *Castoroides ohioensis* from St. Joseph County, Indiana.

University of Notre Dame.

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Hay, O. P. 1923. (Pleistocene of Eastern North America.) Carnegie Institute of Washington, Publ. no. 322, pp. 275-278. Also maps no. 28 and 30.

——— 1912. The Pleistocene Period and Its Vertebrata. 36th Ann. Rept. Dept. Geol. and Natural Resources (of Indiana). 1911. pp. 755-768. Pl. xxviii, xxix, and xxx.

EXPLANATION OF FIGURES

Fig. 1. Lower incisor of *Castoroides ohioensis;* from a photograph on which is written, in faded ink: "Recently found in St. Joseph County. '1896'. Property of Mr. Geo. Baker, South Bend, Ind." x 3/5.

Fig. 2. Photograph showing ventral surface of Giant Beaver skull found near Niles, Michigan. x 1/3.

Fig. 3. Same, from the side. x 1/3.

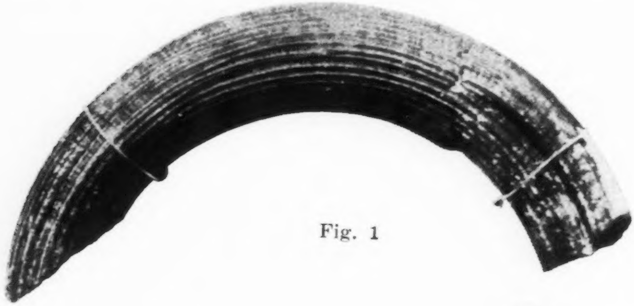

Fig. 1

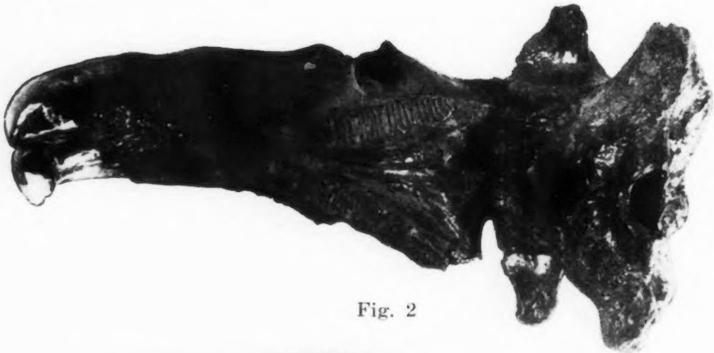

Fig. 2

Fig. 3

STRUCTURE AND CLASSIFICATION OF CERTAIN CYCADOFILICINEAN ROOTS FROM THE McLEANSBORO FORMATION OF ILLINOIS

J. H. HOSKINS

It is difficult to identify with certainty unattached Cycadofilicinean roots. Roots generally, because of a common plan of organization, may easily be confused. However, due to the careful researches of Scott (2), Williamson and Scott (3-4), Arbor (1) and others, we now possess such detailed accounts of the structure of some Cycadofilicinean roots as to make their identity known, even when unaccompanied by other structures of the plant.

Sections of coal balls from the McLeansboro formation of Illinois, prepared from petrifactions collected by Dr. A. C. Noé, and very kindly turned over to the writer for investigation, show numbers of roots varying in size from approximately half a millimeter to over a centimeter in diameter, and in one instance show a very close developmental series. It is the purpose of this paper to describe the anatomical features of some of these roots and to discuss their classification.

Roots of *Medullosa* sp.

In the absence of any considerable amount of information concerning the occurrence of *Medullosa* in American petrifactions, obviously it is impossible to assume any specific relationship in connection with unattached roots which have the anatomical characteristics described for European species of *Medullosa*. Therefore these specimens are merely designated as "roots of *Medullosa*."

Fig. 1 shows a root with a diameter of a little more than a centimeter. It is bordered on the outside by a broad definite zone of small, radially arranged cells which stand out sharp and distinct, although the cell wells are not particularly thick. This tissue is obviously periderm, the cell walls of which were probably suberized.

The central portion of the root is composed of stelar elements. In the center may be seen a triarch zone of primary xylem, with the three arms considerably extended and terminated with very small cells with spiral thickenings. These small cells compose the protoxylem. The larger tracheids of the primary wood are closely pitted on all faces with bordered pits.

Surrounding the primary xylem is a relatively broad zone of secondary wood with its elements radially arranged and obviously the product of a cambium. The tracheids of the secondary xylem are pitted similarly to those of the primary wood, except that the pits generally are restricted to the radial walls. Exterior to the wood may be seen the cambium and secondary phloem. These tissues usually are not preserved, but in some instances show clearly. The phloem consists of sieve tubes and parenchyma. In the sections observed, phloem sclerenchyma might be identified with difficulty.

Rays are numerous and are composed of radially elongated thin-walled parenchymatous tissue. They are more conspicuous opposite each protoxylem point, although distributed generally. They frequently extend from the beginning of the secondary xylem throughout its entire width, continuing through the phloem where the rays immediately become dilated, resulting in the formation of wedge-shaped areas of sieve tubs (fig. 1).

The tissues between the secondary phloem and periderm are commonly absent in the larger specimens. Occasionally there is some evidence of loosely arranged parenchymatous tissue comprising a very narrow zone surrounding the stele. But for further details of the organiation of the root, it will be necessary to observe younger specimens.

Fig. 2 shows a transverse section of a small root with a diameter of approximately 1.6 millimeters. The periderm bounds the root. The primary wood, while slightly distorted, appears to be tetrarch in this instance, an exceptional condition for this root in these sections. Exterior to the wood is a narrow region of phloem surrounded by a zone a few cells in

width, of loosely arranged, almost lacunar tissue. Large numbers of 'secretory sacs' are present in this tissue. Longitudinal sections show these to be more nearly canals than sacs, often extending the length of three or four cells. Bounding this region exteriorly is the periderm which is, in this section, the peripheral tissue of the root.

Thus far it would seem that the origin of the periderm was sub-epidermal, or at least superficial, and constituted the peripheral tissues of the root even in the early phases of its development. Scott (2), however, has traced the development of the root in *Medullosa anglica,* and has shown that the origin of the periderm is not superficial, but is deep-seated in the pericycle, which is several cells in thickness. Fig. 4 bears this out. Here is a rootlet approximately .9 millimeter in diameter. The triarch stele has produced but a few cells of secondary xylem; the primary phloem, lying in the arcs between the protoxylem points, is clearly seen. Surrounding the vascular elements is a zone of two or three cells in thickness, parenchymatous in character and loosely arranged, altogether comparable to the similar region observed in the larger root. Secretory canals are present. This tissue joins the developing periderm the width of which at this stage consists of but three or four radially arranged cells.

Exterior to the periderm is a region of cortical tissue with large cells, loosely arranged, with secretory canals present, bounded by the epidermal tissue consisting of two rows of characteristic cells, relatively large and slightly radially elongated.

This section shows the internal origin of the periderm. If the origin were superficial, one of the rows of cells interior to the periderm might be identified as an endodermis, but there is no evidence of such a tissue in this region. Furthermore, here is direct evidence of the occurrence of cortex exterior to the periderm. Consequently it appears that the periderm originated deep within the pericyclic region and that the epidermis and cortex were cast off early in the development of the root.

The smallest roots are frequently less than half a millimeter in diameter. The primary xylem may be either diarch or triarch. Fig. 5 shows a small root with a triarch xylem strand before the development of any secondary wood or periderm has taken place. In these smallest rootlets the conducting elements may consist of but a few tracheids and a few cells interpreted as phloem. Surrounding these vascular elements is the pericycle of two or three rows of cells, followed exteriorly by a narrow cortex with the characteristic secretory canals, and finally by the epidermal tissue, comparable with the older roots in every way with the exception of the secondary tissues.

This root, while very similar to the descriptions of *Kaloxylon,* the root of *Lyginopteris,* differs from it in the early formation of periderm. Williamson and Scott (4) state that "we find no distinct formation of periderm in the older roots, though sometimes a few tangential divisions took place in the pericycle . . ." *Lyginopteris* roots have a triarch stele rarely, while it is the usual situation for *Medullosa. Amyelon radicans,* the root of *Cordaites,* agrees with both these points, but differs in the character of the primary wood, having tracheids with scalariform thickenings, while these tracheids are closely pitted. *Amyelon* also has denser wood with less parenchyma (2).

While the roots described above were not found attached, their anatomical features are so in exact accord with the descriptions of roots known to belong to *Medullosa* that we have no hesitation in assigning these specimens from Illinois to the same genus.

STRUCTURE OF OTHER CYCADOFILICINEAN ROOTS

Some of the most striking fossils in these sections are roots distinctly different from those described above. It is possible that more than one genus is involved, although all show many points of agreement. These roots may reach a diameter of over a centimeter in our material, and may be recognized at a glance under low magnification or with the unaided eye because of their symmetry in conjunction with the relatively

large calibre of the tracheids of both the primary and secondary wood. Almost all are tetrach, although one large root is pentarch, and a smaller specimen appears to be triarch.

The primary wood often is beautifully preserved, and in the usual tetrarch forms is almost square, with the exception of the protoxylem points, which may be much extended (fig. 4). The tracheids of the primary wood are closely crowded on all faces with bordered pits; a few smaller elements associated with the protoxylem may be scalariform; the protoxylem itself, as usual, is spiral. While there is parenchyma associated with the primary wood, there is nothing comparable to a pith, nor to a separation of the primary xylem into distinct strands.

The primary wood is relatively large. The larger cells are in the center of the strand, and there is a gradual reduction in size toward the protoxylem points. These larger cells are of almost the same diameter as the tracheids of the secondary xylem opposite them. The secondary wood is divided very definitely into segments corresponding in number with the protoxylem points. Usually there are four (fig. 4). Secondary xylem is first formed opposite the sides of the primary strand between the protoxylem regions and it is only after the root has attained a considerable size that the cylinder of wood is practically continuous. In many specimens, regardless of the size of the root, no secondary wood forms opposite the protoxylem.

The production of periderm is a matter of some interest in these specimens. In fig. 5 there is a very great development of periderm, which is at least twenty-five cells wide in places, with evidence that an unknown quantity has been lost exteriorly. A comparable situation is seen in fig. 6, in which the root is the usual tetrarch rather than the pentarch arrangement of fig. 5. In fig. 7, however, which shows a root of approximately the same size and in which the cellular detail is practically identical, there is no such periderm developed. This absence of a definite periderm is the most common situation. There is, however, in every instance where abundant

periderm is lacking, a number of tangential divisions which result in the production of a few radially arranged cells, rarely more than six or eight in number, and usually less. These cells are large and apparently remain parenchymatous, because frequently they show a greater degree of destruction than the irregularly arranged cells just exterior to them, in which the tangential divisions have their origin.

Size of the root is not a factor in determining whether or not periderm is present. Very small roots may be found with a definite periderm formation, while fig. 7 shows a root a centiemter in diameter in which periderm is almost entirely lacking, there being but a few tangential divisions. It may be noticed in figs. 5, 6 and 8, which have abundant periderm, that the extensions of the protoxylem arms are longer, and that there is a greater production of smaller rows of secondary wood nearer the protoxylem regions. While this is generally true of these roots with periderm, it is not always so, one specimen with no periderm having numerous rows of smaller secondary tracheids developing opposite the elongated protoxylem arm.

The tissues just exterior to the wood are not sufficiently well preserved to warrant a comparison or description. In those roots with periderm, it is probable that the origin of this tissue was in the pericycle and that the cortex was lost early in the development of the plant. There is not a series available to trace the development. In those specimens with little or no periderm it is possible that the peripheral tissue is pericyclic, and not cortical.

No attempt will be made to give generic names to these specimens. They are obviously roots, and of the general type known for members of the Cycadofilicales. It is even uncertain whether we are dealing with one root or two, and while the decided differences in the periderm formation point strongly toward the latter assumption, the similarity of the details of the xylem, both primary and secondary, indicates a very close relationship between the two, if, in fact, they are not the same.

The obvious pitting of the tracheids of the primary wood prevents a Cordaitean affiliation. Those with periderm would seem to be excluded from *Lyginopteris*. The small amount of parenchyma in the primary wood also mitigates against this designation, as does the small number of protoxylem points. These roots conform much more readily to the descriptions of the roots of *Medullosa*, although the latter is usually triarch and not tetrarch or pentarch.

The roots without periderm are of the 'Kaloxylon' type, differing in the possession of a smaller number of protoxylem points than is usual for Lyginopteris, and having less wood parenchyma in the primary xylem. They agree in the lack of periderm formation and in the possession of a small number of tangential divisions of the pericycle.

The usual symmetry of the stele, and the characteristic tetrarch condition of the primary xylem agrees very closely with that of a rootlet described by Williamson and Scott (4, fig. 27, pl. 27) as a root probably belonging to *Heterangium Grievii*. This latter root may, however, be that of a *Medullosa*.

Because of the striking character of these fossils in section, and because of their common occurrence in some of our petrifactions, it has seemed desirable to figure them in connection with an anatomical description, although, unfortunately, it is necessary to await further observations before being in a position to ascribe them with certainty to their proper classification.

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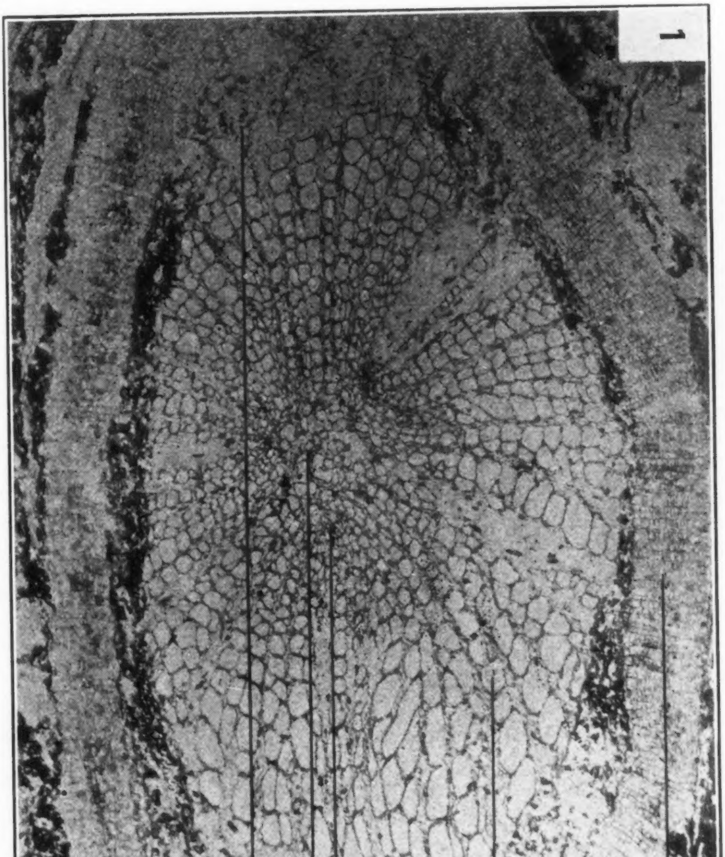
EXPLANATION OF PLATES

The following abbreviations explain figures 1-9: br, lateral root; ca, cambium; cor, cortex; ep, epidermis; pd, periderm; pe, peripheral tissue of older root other than periderm; per, pericycle; ph, phloem; px, protoxylem; rt, rootlet; X^2, secondary xylem; X^1, primary xylem.

Figs. 1, 2, 4, 5 show transverse sections of the root of *Medullosa* sp. Figs. 3, 6, 7 show transverse sections of a Cycadofilicinean root, probably a *Medullosa*, with a broad zone of periderm. Figs. 8, 9 show transverse sections of a Cycadofilicinean root without periderm formation comparable to the root of *Heterangium* as described by Williamson and Scott. This may also be a root of *Medullosa*.

The magnifications of figs. 1-9 are as follows: 1, X20; 2, X45; 3, X22; 4, X40; 5, X40; 6, X15; 7, X20; 8, X12; 9, X20.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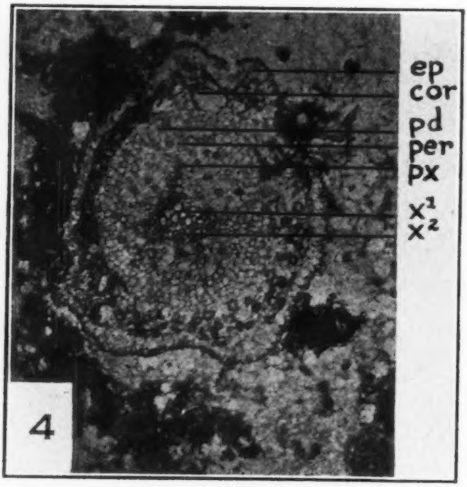
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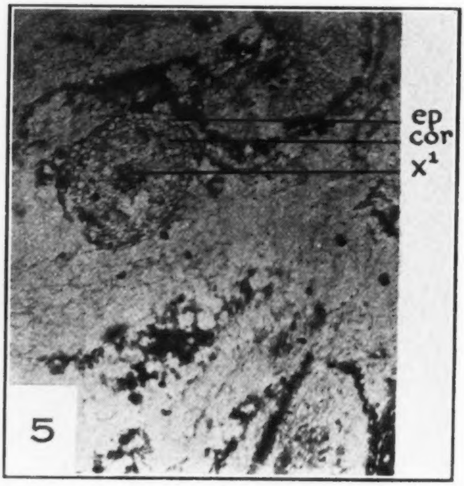
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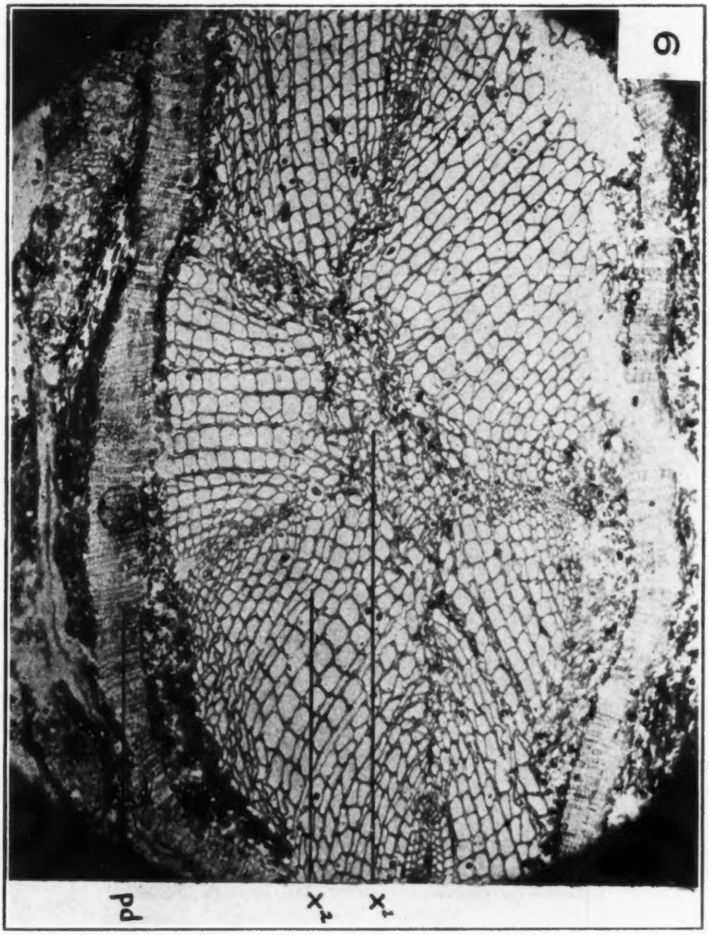
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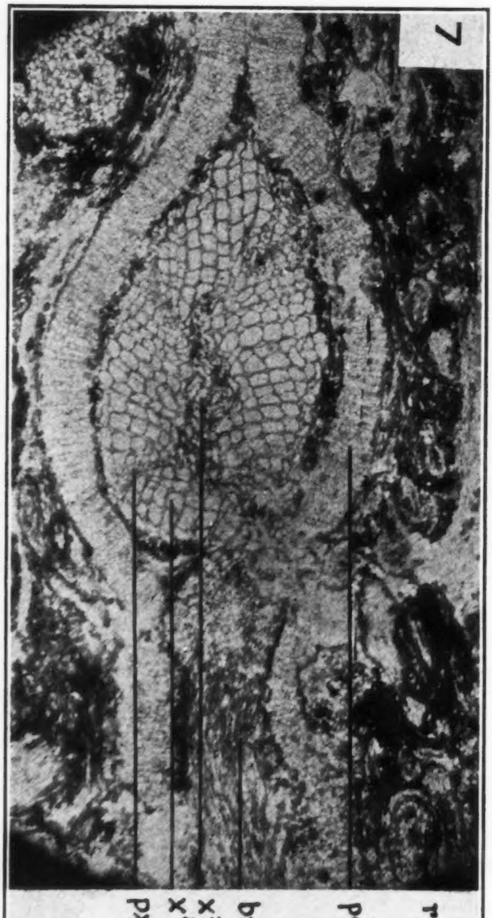
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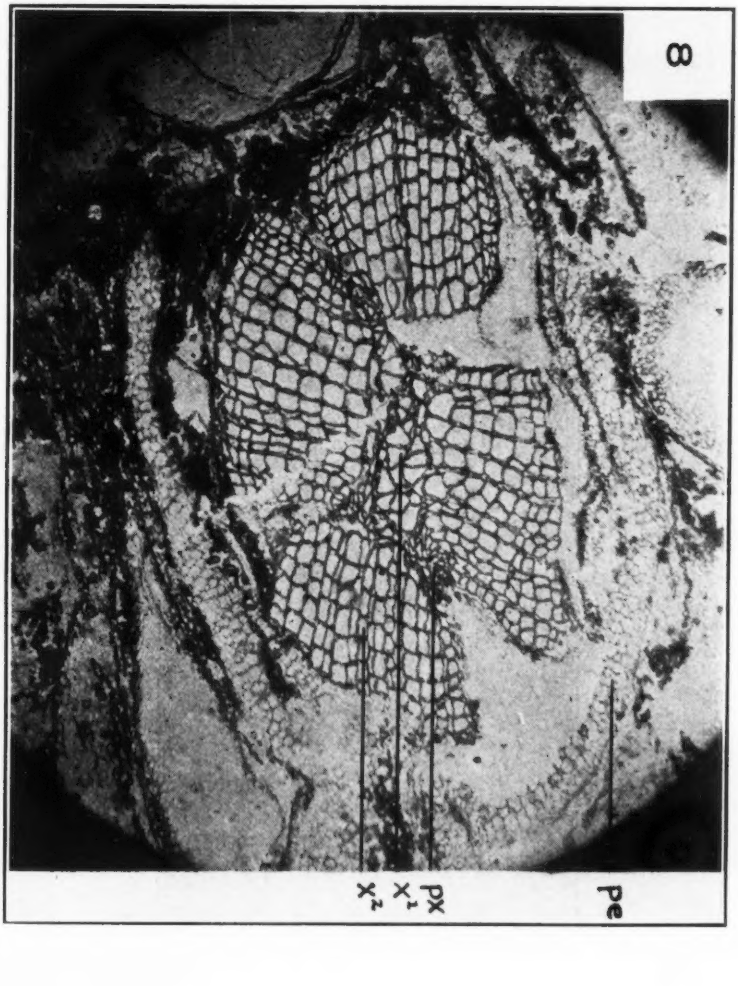
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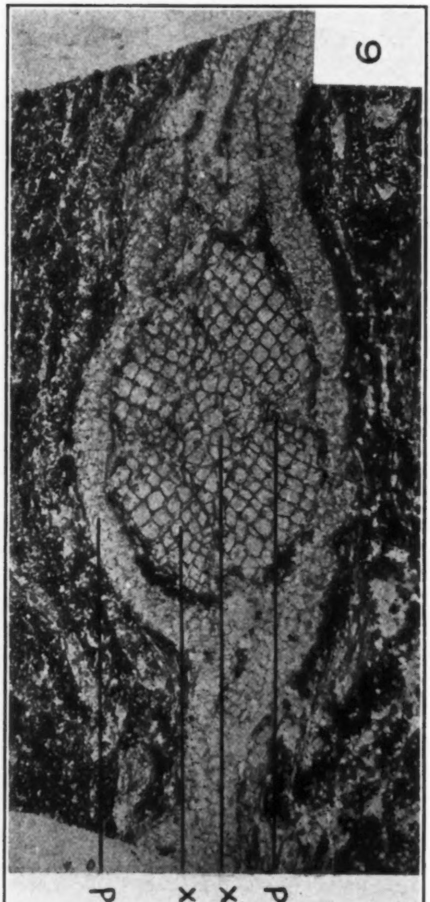
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Book Review

PLANT LIFE THROUGH THE AGES, by A. C. Seward, Cambridge, the University Press; New York, Macmillan, 1931. xxii + 601 pp., 139 figs. $10.00.

In the fourth, and final volume of his textbook on *Fossil Plants,* Professor Seward promised his readers "a general review of the Floras of the Past, . . . published as an independent work more intelligible . . . to the general reader than the text-book which with a certain sense of relief, is now brought to a conclusion." The present volume is the fulfillment of that promise.

Plant Life Through the Ages is written, therefore, for the lay reader as well as the student of botany and geology. For this reason there are six introductory chapters whose chief purpose is to outline the history of the earth, the nature of plant fossils, and the general classification of plants, living as well as extinct. Two of these chapters, those dealing with the "Crust of the Earth" and "Geological Cycles," are remarkably lucid expositions of geologic facts and theories by means of selected cases. Chapter IV, reviews the historical and biologic significance of ice ages, and contains a brief statement of Wegener's hypothesis of continental drift. It is interesting that, although Professor Seward finds this theory of no great value in interpreting the distribution of plants, he makes no mention of the possibilities of Matthew's theory of polar radiation. Rather, he seems to hold to the biologically as well as tectonically outmoded land bridges, so recklessly thrown from continent to continent by one school of paleogeographers.

Chapters VII to XVII contain compact reviews of the floras of the past, with considerable emphasis on their ecologic relationships and environmental significance. In discussing Pre-Cambrian plants Professor Seward is frankly skep-

tical: to him such forms as *Cryptozoon, Atikokania, Collenia,* and the like, are almost certainly the results of Liesegang phenomena in calcareous sediments; algae, if concerned at all in the production of the calcareous masses, are but incidentally imprisoned during their growth. This attitude is not new, and it certainly is more welcome than an uncritical acceptance of of all the species and genera of Proterozoic algae that have been described. Yet the possibility remains that occurrence and field relationships of these problematic structures are as significant as their resemblance—often not very close—to acknowledged concretions, so that the question is by no means closed. Professor Seward's well-stated skepticism should act as a stimulus to those who still find evidence that *Collenia* and its kind represent organisms.

In discussing the floras of the early Paleozoic seas, Professor Seward rightly gives slight attention to those abundant, poorly preserved structures which it was the fashion, some decades ago, to describe as plants (fucoids) and which today—perhaps also as a matter of fashion—are generally dismissed as unimportant borings. As Professor Seward points out, these fossils tell little that is significant in the larger aspects of plant history; while existing studies of them are so casual, and collections so scanty, that little can be done with them on the environmental side. It is neither his contention nor that of the reviewer, that they deserve this neglect—but until it is remedied, they contribute little to our understanding of life in the Paleozoic.

From the Devonian onward, floras become less fragmentary and problematical, and the detail and certainty of description increases correspondingly. In the matter of history it leaves little to be desired, for floras are analyzed period by period, and the analyses supplemented by abundant references to original literature, as well as concise tables showing succession and distribution. The student who is equipped with a copy of Seward and a fairly good reference library should have little difficulty in securing such paleo-

botanical information as may be demanded in the ordinary course of stratigraphic work.

In the face of such detail, it seems pointless to attempt any general summary of the information contained in the volume, or any criticism of points open to debate. With the possible exception of such hypothetical continents as Gondwanaland, (whose climate is summarized on page 258!), Professor Seward maintains an attitude of cautious reserve, even in the statement of his own opinions. In other fields of paleogeography, and in those of evolution, he avoids most of the pitfalls which have entrapped other workers, though his suggestions as to the relationship which must have existed between evolving plants and changing environments incite to speculation.

Physically, the book is pleasing. The 139 figures, which include both drawings and photographs, are well printed though the restorations of floras might have been more convincing in another medium than line. There is a bibliography of 39 closely printed pages, and an excellent index. —Carroll Lane Fenton.

IN MEMORIAM

The University of Vienna mourns the death of Professor Richard Wettstein (August 10, 1931).

Professor Wettstein was born in Vienna, June 30, 1863, where he received his entire education. His whole life represents a splendid scientific career beginning as an assistant to Professor Anton Kerner, followed by an appointment to an Assistant Professorship in the German University at Prague. From there he returned to Vienna as successor of Kerner in the Professorship of Systematic Botany and as Director of the Botanical Garden. This position he held for 32 years until his death.

His fame is well-founded on his extensive researches and achievements in the various fields of botany which culminated with the development of his system set forth in his "Handbuch der Systematischen Botanik" (3rd. ed., Vienna, 1924). Taxonomic and allied plant-geographical problems were of special interest to him, and paleobotany, morphology and ecology owe him valuable contributions. Furthermore, his phylogenetic studies led him to the development of species and other similar problems of a general nature. Two of his monographs (*Euphrasia* and *Gentiana*) studying seasonal dimorphism and the development of geographical races have become outstanding. Thorough and detailed in his studies, he exhibited a just objectivism and critical attitude combined with an unusual synthetic ability. This was his great merit as a teacher accompanied by a fascinating manner of presentation unforgettable to his students. The latter also lost in him a friend whose helpful assistance in the Students Welfare Institutions was especially felt and deeply appreciated ever since 1918.

Professor Wettstein received many honors from Austrian and foreign scientific societies. As Senator of the Kaiser-Wilhelm-Gesellschaft in Berlin he used his wide influence in the service of German post-war research.

The man Wettstein showed an exceptionally harmonious character and a winning personality that made contact with him a privilege.

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NOTE

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